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SUBSTRATE AND WORKPIECE CARRIER FOR HOLDING THE SUBSTRATE

FIELD OF THE INVENTION

The present invention relates to a workpiece carrier for holding a substrate, for example, a thin film substrate and a substrate.

BACKGROUND INFORMATION

Stainless steel substrates having molded membranes, to which various functional layers are applied using thin film technology, are normally used to produce sensor elements, for example, high-pressure sensor elements. These functional layers include, for example, insulating layers, sensitive resistance layers, electrically conductive layers, from which conductors or contacts may be structured, and passivation layers.

In mass-producing a single-substrate sensor element, it is economical to process the elements in groups. For this purpose, conventional concepts meet different requirements of the specific individual thin film production process. Thus, the substrate is usually held on a workpiece carrier, which is used to position the substrate during individual process steps.

A conventional method places the substrate in a very massive workpiece carrier at the beginning of the thin film production and leaves it in this massive workpiece carrier throughout the thin film production process. The workpiece carrier is extremely heavy and has a considerable installation height, making it difficult to perform individual process steps. In addition, this design requires complicated screw connections. Furthermore, media entrainment may occur, particularly during treatment with liquid media, making mass production difficult.

Another conventional method uses a separate workpiece carrier adapted to the type of processing for each individual thin-film production process step. Between the individual process steps, the substrates must be placed in the special workpiece carrier and then removed again at the end of the process step. A disadvantage of this is that it requires considerable assembly and handling effort, and, due to the large number of possible process steps, errors may occur when positioning the substrate, so that considerable waste poses another obstacle to mass production.

SUMMARY

An object of the present invention is to use a substrate and a workpiece carrier for holding the substrate, for example, a thin film substrate. Since the workpiece carrier has a base element for holding the substrate, the base element may be arranged on a handling element, and the base element may be assigned process-dependent cover elements on a side opposite the handling element, it is possible to economically mass-produce the sensor elements. The substrate and the workpiece carrier each have at least one complementary positioning element that is used to fix the substrate in a relative spatial position (positioning unit). The positioning unit makes it possible to prevent axial displacement or radial twisting of the substrate in the base element during thin film production, thus reducing production-related waste, for example, when automating the thin film production process. For this purpose, the substrate may have, for example, a groove or notch provided in the side wall of the substrate, and the base element may have a complementary lug that engages with the groove when the substrate is inserted into the base element.

According to an example embodiment of the present invention, the base element has individual carrier elements on which a contact surface of the substrate is supported. For example, this contact surface may be formed by a lower edge of a collar provided around the circumference of the substrate. The

carrier elements may extend into a location hole in the base element. This makes it possible to position the substrate on the carrier elements of the base element so that at least one opening extends between one edge of the location hole in the base element and a side wall of the substrate. This provides sufficient transparency for liquid media, which are used in certain process steps, making it possible to effectively prevent media entrainment.

The handling element and cover elements may be provided with an arrangement for relative positioning to one another. For example, the arrangement may be guide pins, turn-lock fasteners, expansion pins, mechanical stops, etc. This makes it possible to precisely position the cover element on the handling element.

In addition, the handling element and/or the cover elements may be provided with a coding arrangement by providing, for example, notches, bar codes, holes, etc. on the surfaces of the handling elements. This makes it possible to automate the thin film production process with greater process reliability so that it is suitable for mass production.

In an example embodiment of the present invention having individual supporting elements, the cover elements rest against a supporting surface of the substrate, for example, an upper edge of the collar provided around the circumference of the substrate. The cover element has process areas that permit selective treatment of one surface of the substrate (mask). During treatment with liquid media, for example, the cover element is positioned on the substrate, so that the process areas are above the openings between the base elements and the substrates, thus ensuring a high degree of transparency for the liquid medium.

During treatment of the substrate surface of the substrate by deposition, plasma etching, photolithography, passivation,

similar methods, etc., the cover element may form a seal with a circumferential edge of the substrate surface. Not only does this enable more accurate positioning, but it also further suppresses media entrainment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of a sensor element including various functional layers on a substrate.

Figure 2 includes three different views of a substrate for thin film production.

Figure 3 is a top view of a base element for holding the substrate.

Figure 4 is a top view of a handling element on which a number of base elements are provided.

Figure 5 includes a sectional view and a top view of a workpiece carrier and the substrate in the region of a base element during treatment of a substrate surface with a liquid medium.

Figure 6 includes a sectional view and a top view of a workpiece carrier and the substrate in the region of a base element during treatment of a substrate surface by deposition, plasma etching, similar methods, etc.

Figure 7 is a sectional view of a workpiece carrier and the substrate during passivation of the substrate surface and precipitation of a contacting layer using shadow masking technology.

Figure 8 is a perspective side view of a work bench for holding the workpiece carrier.

Figure 9 is a perspective side view of a work bench arrangement for holding the workpiece carrier during automated thin film production.

DETAILED DESCRIPTION

Figure 1 is a sectional view of a sensor element 10 on which different functional layers are applied to a substrate 12, based on conventional thin film technology. Functional layers of this type include sensitive layers 14, a contacting layer 16, a passivation layer 18 and an insulating layer 20, which are provided on a substrate surface 22. It is also possible to incorporate additional form features into substrate 12 without limiting the functionality of sensor element 10. For example, a collar 24, which supports the thin film production process, may be provided around the circumference of substrate 12.

Figure 2 also illustrates substrate 12 in a variety of detailed views. The radial structure of substrate 12 is interrupted in the area of a groove 26, which is milled into a side wall 27. Groove 26 is a positioning element 29, which is described in greater detail below.

Throughout the production process of sensor element 10, individual substrates 12 are provided in a base element 28, which, in turn, is part of a handling element 30. Figure 4 is a top view of a handling element 30 of this type, and Figure 3 is a top view of an individual base element 28 of handling element 30.

As illustrated in Figure 3, substrate 12 is positioned with a contact surface 32 on individual carrier elements 34 of base element 28. Base element 28 forms a location hole 36 into which carrier elements 34 extend. According to an example embodiment of the present invention, contact surface 32 is formed by a lower edge 38 of collar 24. As illustrated in the top view of Figure 3, multiple openings 40 extend between an edge 42 of base element 28 and substrate 12. If necessary,

liquid media, which are used in a process step during thin film production for treating or cleaning sensor surface 22, may flow off through openings 40.

Base element 28 also has a rectangular lug 44 as a complementary positioning element 31, which also extends into location hole 36. During thin film production, substrate 12 is inserted into location hole 36 in base element 28 so that lug 44 engages with groove 26. In this manner, substrate 12 is fixed in a relative position, and both positioning elements 29, 31 serve as a positioning unit. The positioning unit may be adapted in a variety of manners to the given geometric requirements of substrate 12.

A number of base elements 28 corresponding to the given dimensions may be arranged on handling element 30. The hexagonal basic structure of base elements 28, according to an example embodiment of the present invention, makes it possible to arrange the elements particularly close together. Handling element 30 also has openings 46, 48, which serve to position handling element 30, and a cover element 50, which is described in greater detail below, during the individual process steps and/or to position a workpiece carrier (handling element 30 and cover element 50) on a work bench 80, in a manner described in greater detail below. Opening 46 may hold, for example, a turn-lock fastener, while opening 48 may be used to hold guide pins, expansion pins or similar devices.

Furthermore, handling element 30 and/or cover elements 50 may be provided with a coding arrangement to enable automation of the thin film production process. For example, holes 52 on a surface 54 of handling element 30 may provide information about the progress of the process or similar details. Notches 56 may be used to detect a relative position of handling element 30 using suitable sensors.

Throughout the thin film production process, substrate 12 is fixed to base element 28, as described above. In each subsequent process step, a process-dependent cover element 50 is placed on substrate 12. For this purpose, substrate 12 has a supporting surface 58, for example, on an upper edge 60 of collar 24, and cover element 50 has corresponding supporting elements 62 (see Figures 2 and 5).

Figure 5 illustrates a cover element 50 similar to those customarily used in the treatment of substrate surface 22 with a liquid medium. Substrate 12 is wetted with the liquid medium in a process area 64, which is provided by a recess in the area of cover element 50. This makes it possible to selectively treat substrate surface 22 by suitably designing process area 64, for example, by covering partial areas of substrate surface 22 with cover element 50. According to an example embodiment of the present invention, process area 64 is selected so that it also extends over openings 40 between base element 28 and substrate 12. Accordingly, the liquid medium may thus flow off or be flushed through openings 40 either during or after the process step and thus greatly reduce medium entrainment.

If the process steps involve treating substrate surface 22 by deposition, plasma etching, photolithography, a similar method, etc., cover element 50 may be adapted accordingly (see Figure 6). For this purpose, a sealing edge 68 of cover element 50 is flush against a circumferential edge 66 of substrate 12 so that only substrate surface 22 is machined during the process step. Extremely accurate positioning of substrate 12 may be achieved by insertion slopes 69 along which substrate 12 slides while cover element 50 is being placed.

Figure 7 is a sectional view of an arrangement of the individual workpiece carrier elements during the provision of conductors or during passivation of substrate surface 22.

Cover element 50 includes a positioning plate 70, a pressure plate 72 and a shadow mask 74 provided between these two plates 70, 72. On a bottom of base element 28, a further pressure plate 76 and a spring plate 78 are used to apply a force to substrate 12, so that substrate surface 22 lies flat against shadow mask 74 during the process step.

According to the process steps during thin film production of a sensor element 10, illustrated by way of example in Figures 5 to 7, substrate 12 remains in base element 28, and only cover elements 50 are exchanged. If necessary (see Figure 7), additional elements supporting the process step, for example, a pressure plate 76 and a spring plate 78, may be assigned to base element 28.

The workpiece carrier may be fixed in place throughout the production process. As described above, an arrangement, such as guide pins, turn-lock fasteners, expansion pins, mechanical stops, etc., are suitable for this purpose. The workpiece carrier may be fixed to work bench 80 during thin film production, as illustrated by the perspective side view in Figure 8. For this purpose, work bench 80 has guide pins 82, location holes 84 for positioning elements or spacers 86 on its surface 88. Discharge openings 90 may be integrated for fluid media into work bench 80.

Figure 9 is a schematic view illustrating a possible method of automation of thin film production using a robot 92. According to a pending process step, a robot arm 94 takes a cover element 50 from a cassette 96 and places it on handling element 30, which is provided on work bench 80. On the basis of holes 52 and notches 56 in handling element 30, for example, it is possible to determine a relative position and a pending process step using suitable sensors. After completion of the process step, cover element 50 is replaced in cassette 96 and the next process step begins.